

WHAT IS CLAIMED IS:

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1. An active-matrix image display device which includes a power supply of a charge-pump system, and drivers which come into operation in response to supply of power from the power supply to drive display cells,

said drivers having two operation modes including a scanning mode in which a video signal is applied to any of the display cells, and a hold mode in which no video signal is applied to the display cells,

said active-matrix image display device comprising:

mode switching means for periodically changing the operation modes so that duration of the hold mode is equal to or longer than duration of the scanning mode; and

control means for switching, according to the operation modes, a frequency at which pump operation of the power supply is activated.

2. The active-matrix image display device as set forth in claim 1,

wherein:

an operating current value in the scanning mode of the drivers and an operating current value in the hold mode of the drivers differ by 10 times or more, and

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a frequency of the pump operation is decided according to a maximum value of operating current values of the drivers, and circuit elements of the power supply are arranged according to the frequency of the pump operation.

3. The active-matrix image display device as set forth in claim 1, wherein said power supply includes a first oscillator which generates a first clock signal which is used as a reference in the pump operation of the power supply in the scanning mode.

4. The active-matrix image display device as set forth in claim 3, wherein said power supply includes a divider which divides the first clock signal to generate a second clock signal which is used as a reference in the pump operation of the power supply in the hold mode.

5. The active-matrix image display device as set forth in claim 3,

wherein:

said power supply includes an input terminal for inputting a second clock signal which is used as a reference in the pump operation of the power supply in

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the hold mode, and

oscillator control means for inactivating operation of the first oscillator during at least a part of a period of the pump operation operated by the second clock signal.

6. The active-matrix image display device as set forth in claim 3,

wherein:

said power supply includes a second oscillator which generates a second clock signal which is used in the pump operation of the power supply in the hold mode, and

oscillator control means for inactivating operation of the first oscillator during at least a part of a period of the pump operation operated by the second clock signal.

7. The active-matrix image display device as set forth in claim 1, wherein the scanning mode and the hold mode are repeated periodically with a period of several hundred msec.

8. The active-matrix image display device as set forth in claim 1, wherein a period of the hold mode is

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set to be several times to several ten times longer than a period of the scanning mode.

9. The active-matrix image display device as set forth in claim 1, wherein said control means makes up said mode switching means, and, when increasing frequency, switches the frequency in advance a predetermined time interval before switching of the operation modes, so that the increase of frequency is finished by the time the switching of the operation modes is started.

10. The active-matrix image display device as set forth in claim 1, wherein among power consumption of an image display section including the display cells and the drivers, power consumption in the hold mode is lower than power consumption of the control means and the power supply itself in the scanning mode.

11. The active-matrix image display device as set forth in claim 1, comprising:

a first power supply for multiplying an input voltage by a predetermined constant factor;

a regulator for generating a first voltage by stabilizing an output voltage of the first power supply

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to a predetermined value, and supplying the first voltage to the drivers; and

a second power supply for generating a second voltage by multiplying the first voltage by a predetermined constant factor, and supplying the second voltage as an ON voltage or an OFF voltage to a scanning signal line driver, which is one of the drivers,

wherein at least one of the first power supply and the second power supply makes up the power supply under control of the control means.

12. The active-matrix image display device as set forth in claim 1, comprising:

a first power supply for raising an input voltage by a predetermined factor;

a regulator for generating a first voltage by stabilizing an output voltage of the first power supply to a predetermined value, and supplying the first voltage to the drivers;

a second power supply for raising the first voltage by a predetermined factor, and supplying the first voltage as an ON voltage of a scanning signal line driver, which is one of the drivers; and

a third power supply for inverting and raising the

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first voltage by a predetermined factor, and supplying the first voltage as an OFF voltage of the scanning signal line driver, which is one of the drivers,

wherein at least one of the first power supply, the second power supply, and the third power supply makes up the power supply under control of the power supply.

13. Portable electrical equipment with an image display device,

said image display device being an active-matrix image display device which includes a power supply of a charge-pump system, and drivers which come into operation in response to supply of power from the power supply to drive display cells,

said drivers having two operation modes including a scanning mode in which a video signal is applied to any of the display cells, and a hold mode in which no video signal is applied to the display cells,

said image display device comprising:

mode switching means for periodically changing the operation modes so that duration of the hold mode is equal to or longer than duration of the scanning mode; and

control means for switching, according to the

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operation modes, a frequency at which pump operation of the power supply is activated.

14. An active-matrix image display device which includes a power supply of a charge-pump system, and drivers which come into operation in response to supply of power from the power supply to drive display cells,

said drivers having two operation modes including a scanning mode in which a video signal is applied to any of the display cells, and a hold mode in which no video signal is applied to the display cells,

said power supply maintaining an output voltage value by a smoothing capacitor which is maintained at an output of the power supply while the pump operation is inactive,

said power supply including:

control means for stopping the pump operation of the power supply according to the hold mode; and

mode switching means for periodically changing the operation modes so that duration of the hold mode is equal to or longer than duration of the scanning mode.

15. The active-matrix image display device as set forth in claim 14, wherein the scanning mode and the hold mode are periodically repeated with a period of

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several hundred msec.

16. The active-matrix image display device as set forth in claim 14, wherein said mode switching means periodically switches the operation modes so that duration of the hold mode becomes equal to or longer than duration of the scanning mode, and a drop margin of the output voltage value when the pump operation is resumed is not more than 10 % of an output voltage value to be maintained.

17. The active-matrix image display device as set forth in claim 14, wherein said mode switching means switches the operation modes so that duration of the hold mode becomes equal to or longer than duration of the scanning mode, and a recovery time required for an output voltage value which dropped while the pump operation was inactive to return to the output voltage value to be maintained from resumption of the pump operation is within several ten  $\mu$ sec, and the scanning mode and the hold mode are periodically repeated with a period of several hundred msec.

18. The active-matrix image display device as set forth in claim 14,

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wherein:

an operating current value in the hold mode of the drivers is not more than 0.01 times an operating current value in the scanning mode, and

said mode switching means switches the operation modes so that duration of the hold mode becomes equal to or longer than duration of the scanning mode, and the scanning mode and the hold mode are periodically repeated with a period of several hundred msec.

19. The active-matrix image display device as set forth in claim 14, wherein a period of the hold mode is set to be several times to several ten times longer than a period of the scanning mode.

20. The active-matrix image display device as set forth in claim 14, wherein said control means makes up said mode switching means, and, when resuming pump operation, resumes the pump operation in advance a predetermined time interval before switching of the operation modes, so that the resumption of pump operation is finished by the time the switching of the operation modes is started.

21. The active-matrix image display device as set

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forth in claim 14, wherein among power consumption of an image display section including the display cells and the drivers, power consumption in the hold mode is lower than power consumption of the control means and the power supply itself in the scanning mode.

22. The active-matrix image display device as set forth in claim 14, comprising:

a first power supply for multiplying an input voltage by a predetermined constant factor;

a regulator for generating a first voltage by stabilizing an output voltage of the first power supply to a predetermined value, and supplying the first voltage to the drivers; and

a second power supply for generating a second voltage by multiplying the first voltage by a predetermined constant factor, and supplying the second voltage as an ON voltage or an OFF voltage to a scanning signal line driver, which is one of the drivers,

wherein at least one of the first power supply and the second power supply makes up the power supply under control of the control means.

23. The active-matrix image display device as set

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forth in claim 14, comprising:

a first power supply for raising an input voltage by a predetermined factor;

a regulator for generating a first voltage by stabilizing an output voltage of the first power supply to a predetermined value, and supplying the first voltage to the drivers;

a second power supply for raising the first voltage by a predetermined factor, and supplying the first voltage as an ON voltage of a scanning signal line driver, which is one of the drivers; and

a third power supply for inverting and raising the first voltage by a predetermined factor, and supplying the first voltage as an OFF voltage of the scanning signal line driver, which is one of the drivers,

wherein at least one of the first power supply, the second power supply, and the third power supply makes up the power supply under control of the control means.

24. Portable electrical equipment with an image display device,

said image display device being an active-matrix image display device which includes a power supply of a charge-pump system, and drivers which come into

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operation in response to supply of power from the power supply to drive display cells,

said drivers having two operation modes including a scanning mode in which a video signal is applied to any of the display cells, and a hold mode in which no video signal is applied to the display cells,

said power supply maintaining an output voltage value by a smoothing capacitor which is maintained at an output of the power supply while the pump operation is inactive,

said image display device comprising:

control means for stopping the pump operation of the power supply according to the hold mode; and

mode switching means for periodically changing the operation modes so that duration of the hold mode is equal to or longer than duration of the scanning mode.

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